

## SECTION IV.—RIVERS AND FLOODS.

## THE RIVERS DURING JANUARY.

By ALFRED J. HENRY, Professor of Meteorology.

With few and mostly unimportant exceptions, the rivers were well within their banks during January, as may be read from Chart I, Hydrographs for typical points on several of the principal rivers.

## FLOODS IN THE RIVERS OF SOUTH CAROLINA.

The Wateree at Camden, S. C., was 3.1 feet above the flood stage on the 4th, and the Santee at Rimini, S. C., was above the flood stage from the 1st to the 12th, inclusive.—*Report of Richard H. Sullivan, Section Director.*

*The Pedee River.*—The Pedee was in flood on January 4, cresting at a stage of 29.5 feet at Cheraw, due to heavy rains over the watershed. At Smiths Mills, the next station below Cheraw, the flood stage was not reached.

No appreciable damage was caused in the upper reaches of the river, but in the lower reaches much stock was driven out and thus saved by the warnings that were issued.—*Report of J. H. Scott, Local Forecaster.*

## FLOODS IN RIVERS OF NORTH CAROLINA.

The Roanoke River at Weldon, N. C., was 3.5 feet above the flood stage (30 feet) on the 6th. This flood soon subsided. The Cape Fear River at Elizabethton, N. C., was above flood stage on the 5th, 6th, and 7th. The Neuse River was above the flood stage on the 4th and 6th, at Neuse, N. C. Both floods were of short duration.—*Report of Lee A. Denson, Section Director.*

## FLOOD IN THE SUSQUEHANNA RIVER.

The lower portion of the North Branch of the main river was frozen in places about the end of December, 1913. There were, however, long stretches where the main channel remained open, with ice extending out some distance from the shore.

Warm weather on the 27th and 28th of January caused melting of the snow that had accumulated in the Susquehanna basin; and during the afternoon of the 29th a general breaking up of the ice began on the Chemung, the North Branch, and upper portions of the West Branch.

The ice broke up at Clearfield at 1.30 p. m. of the 29th, moving out on 4.5 feet of water. At Renova, Pa., the ice broke at 2.50 p. m., and passed out on a flood of 11 feet on the same date. At a later date, January 30, the ice passed Williamsport at a stage of 14.5 feet.

No ice gorges formed in the North Branch, the stages being high enough to carry the ice out.

Rain on January 31 complicated the situation somewhat, but the run-off was not sufficient to produce flood stages. No damage was occasioned.—*Report of E. R. Demain, Local Forecaster.*

## THE FLOODS IN THE SACRAMENTO AND SAN JOAQUIN.

The Sacramento and its tributaries were in flood several times during the month, due to heavy rains and melting snows. On the upper stretches of the stream, as at

Red Bluff, the river passed above the flood stage on the 1st, and crested at a stage of 29 feet, 6 feet above the flood stage. This flood wave also produced gage readings above the flood stage at Nicolaus on the Feather, Kennett, Jacinto, Colusa, Knights Landing, and Rio Vista, on the Sacramento; but at Sacramento the flood stage was not reached. The essential statistics of the floods in the Sacramento and San Joaquin Rivers will be found in the table below.

The rainfall in the watershed, while not unusually heavy, occurred in frequent short periods, and as a result there were a number of minor wave crests during the second half of the month, with a steadily rising river, culminating in a stage of 27.8 feet at Sacramento on the 28th. By the end of the month the flood had passed, and the headwater tributary streams were falling. The high water caused a number of breaks in the levees, and an extent of land estimated at 60,000 acres was flooded.—*(After N. R. Taylor, Local Forecaster.)*

*Flood in the upper San Joaquin.*—The first general flood in several years occurred simultaneously in all streams of the upper San Joaquin watershed on the 24th, and culminated on the following day on the Merced River in the highest stage recorded during a period of eight years. Likewise, the highest stage recorded on the San Joaquin at Friant in a period of eight years occurred at midnight of the 25th. In Kings River probably no flood of similar proportions has occurred within the last fifty years.—*(After W. E. Bonner, Local Forecaster.)*

TABLE 1.—Statistics of floods during January, 1914, in the Sacramento and San Joaquin Rivers.

## SACRAMENTO RIVER.

Station.	River.	Highest stage.		Above or below flood stage.	Rainfall.
		Reading.	Date.		
		Feet.		Feet.	Inches.
St. John.....	Stony Creek.....	10.0	1st.....	-2.0	8.91
Colgate.....	Yuba.....	11.8	25th.....	-2.2	19.30
Marysville.....	do.....	21.5	1st.....	-6.5	5.80
Oroville.....	Feather.....	22.0	1st.....	-3.0	12.53
Nicolaus.....	do.....	23.0	1st.....	+2.0	8.14
Folsom.....	American.....	18.8	25th.....	.....	12.14
Kennett.....	Sacramento.....	25.4	2d.....	+0.4	25.58
Red Bluff.....	do.....	29.0	1st.....	+6.0	9.50
Jacinto.....	do.....	23.0	2d.....	+2.0	8.09
Colusa.....	do.....	28.3	4th.....	+0.3	6.97
Knights Landing.....	do.....	18.9	5th.....	+0.9	9.21
Sacramento.....	do.....	27.8	27th.....	-1.2	5.97
Rio Vista.....	do.....	13.6	28th.....	+0.6	9.54

## SAN JOAQUIN RIVER.

Piedra.....	Kings.....	21.8	25th.....	+9.8	.....
Merced Falls.....	Merced.....	10.3	25th.....	+3.3	.....
Friant.....	San Joaquin.....	12.4	25th.....	+4.4	.....
Firebaugh.....	do.....	11.4	28th.....	-0.6	.....
Lathrop.....	do.....	19.7	27th.....	+2.7	5.79
Benson's Ferry.....	Mokelumne.....	13.1	27th.....	+1.1	9.40
Electra.....	do.....	8.5	20th.....	-3.5	14.45
Bellota.....	Mormon Slough.....	20.3	18th.....	+0.3	8.62
Jenny Lind.....	Calaveras.....	6.0	22d.....	-4.0	8.21
Melones.....	Stanislaus.....	6.2	25th.....	.....	13.44
Jacksonville.....	Tuolumne.....	24.0	26th.....	+1.0	11.85

TABLE 2.—Money loss by floods of January, 1914.

District.	Tangible property loss, buildings, highways, etc.	Farms and farm property, including prospective crops.	Stock and movable property.	Total.
South Carolina.....			\$400	\$400
California:				
Sacramento.....	\$370,000	\$200,000	1,000	571,600
San Joaquin.....	80,000	5,500	600	91,000

Hydrographs for typical points on several principal rivers are shown on Chart I. The stations selected for charting are Keokuk, St. Louis, Memphis, Vicksburg, and New Orleans, on the Mississippi; Cincinnati and Cairo, on the Ohio; Nashville, on the Cumberland; Johnsonville, on the Tennessee; Kansas City, on the Missouri; Little Rock, on the Arkansas; and Shreveport, on the Red.

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### FRESHETS IN THE SAVANNAH RIVER

AND THE FORECASTING OF HIGH WATER AT AUGUSTA, GA.

By EUGENE D. EMIGH, Local Forecaster, Augusta, Ga.

[Dated May 16, 1913; revised December, 1914.]

### PREFACE.

This paper is chiefly an explanation and discussion of the river forecast scheme that is used successfully by the writer in predicting high river stages for the benefit of the business and residential interests of Augusta, Ga., and the river farmers, lumbermen, and navigators below Augusta. It is hoped it may prove helpful to river forecasters elsewhere, and interesting to students of river flow.

Acknowledgements are due and are gratefully extended to Profs. H. C. Frankenfield and A. J. Henry, and Mr. H. W. Smith, of the Central Office of the Weather Bureau, Messrs. M. R. Hall and W. E. Hall of the United States Geological Survey, Judge Henry C. Hammond, of Augusta, Hon. Nisbet Wingfield, chief engineer of the river and canal commission of Augusta, and others who have furnished valuable historical and scientific facts and publications, as well as to the office force of the Augusta office of the United States Weather Bureau for assistance on tabular matter and diagrams.

### THE SAVANNAH RIVER.

The Savannah River is a stream bold in all of its features. It is formed by the junction of the Seneca and Tugaloo Rivers about 100 miles above Augusta, Ga. The headwaters of the Seneca River are small streams having their origin chiefly in the mountains of North Carolina. The Tugaloo River results from small streams that rise for the most part in the mountains of north Georgia. Numerous creeks and small rivers enter these tributaries and the other tributaries of the Savannah River as well as the main stream. On the South Carolina side, Rocky River, Little River, and Stevens Creek are the most important streams, while on the Georgia side are found the Broad River, which is the largest of the tributaries, and the Little River, another important stream.

For its size the Savannah River is an unusually restless stream, sensitive to even small amount of rainfall and subject to frequent rises. Here rushing in cascades

over the granite bed, there resting in placid shoals, the water makes on the whole rapid progress; the total fall in 64 miles immediately above Augusta is 257 feet. The course is somewhat irregular and islands are quite numerous in the channel. The last of the cascades begins about 6 miles above Augusta and ends at Augusta, below which point navigable waters move leisurely along a winding course through the low swamps of the Coastal Plain to the Atlantic Ocean. It has been estimated that the Savannah River and the streams tributary to it are capable of generating a minimum of 200,000 horsepower, of which but a small amount is developed.

### Topography and Geology.

Practically all of the catchment basin of the Savannah River above Augusta occupies the Piedmont Plateau. It is characterized by a truly rugged topography of clay hills overlying geologic formations of granite and gneiss. Elevations range from about 200 feet above sea level at the eastern edge of the plateau to 1,000 feet on its western edge. In remote mountain districts the general altitude is about 2,000 feet, with prominences considerably higher. The area of the watershed is 7,294 square miles.

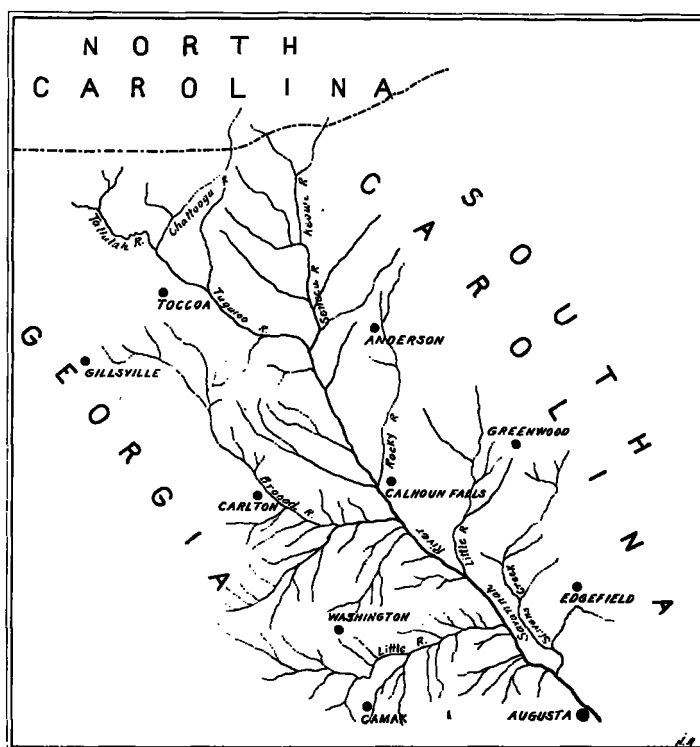


FIG. 1.—The Savannah River watershed above Augusta, Ga. Area 7,294 square miles.

### Forestry conditions.

The South Carolina State Department of Agriculture, Commerce and Industries has published "Bulletin 1, January, 1910. Forest conditions in South Carolina. Report of Preliminary Examination and Survey. By W. M. Moore, forest assistant, United States Bureau of Forestry, Columbia, S. C., 1910." This report gives a description of past and present forest conditions that applies to the Savannah River watershed. The following is copied from his report:

*Alpine region*—Only about 25 per cent of this region has been cleared of forest, and many fields that have been cleared have after